Impact of Health Literacy on Socioeconomic and Racial Differences in Health in an Elderly Population

David H. Howard, PhD,[1] *Tetine Sentell, PhD,*[2] *Julie A. Gazmararian, PhD, MPH*[3]

[1]Department of Health Policy and Management, Rollins School of Public Health, Emory University, Atlanta, GA, USA; [2]Department of Psychiatry, University of California, San Francisco, San Francisco, CA, USA; [3]Emory Center on Health Outcomes and Quality, Emory University, Atlanta, GA, USA.

BACKGROUND: Differences in health literacy levels by race and education are widely hypothesized to contribute to health disparities, but there is little direct evidence.

OBJECTIVE: To examine the extent to which low health literacy exacerbates differences between racial and socioeconomic groups in terms of health status and receipt of vaccinations.

DESIGN: Retrospective cohort study.

PARTICIPANTS (OR PATIENTS OR SUBJECTS): Three thousand two hundred and sixty noninstitutionalized elderly persons enrolling in a Medicare managed care plan in 1997 in Cleveland, OH; Houston, TX; South Florida; and Tampa, FL.

MEASUREMENTS: Dependent variables were physical health SF-12 score, mental health SF-12 score, self-reported health status, receipt of influenza vaccine, and receipt of pneumococcal vaccine. Independent variables included health literacy, educational attainment, race, income, age, sex, chronic health conditions, and smoking status.

RESULTS: After adjusting for demographic and health-related variables, individuals without a high school education had worse physical and mental health and worse self-reported health status than those with a high school degree. Accounting for health literacy reduced these differences by 22% to 41%. Black individuals had worse self-reported health status and lower influenza and pneumococcal vaccination rates. Accounting for health literacy reduced the observed difference in self-reported health by 25% but did not affect differences in vaccination rates.

CONCLUSIONS: We found that health literacy explained a small to moderate fraction of the differences in health status and, to a lesser degree, receipt of vaccinations that would normally be attributed to educational attainment and/or race if literacy was not considered.

KEY WORDS: educational status; health literacy; health status; minority groups.
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Differences in health literacy levels by race, income, and education are widely hypothesized to contribute to health disparities. Healthy People 2010 states that "Equitably distributed health communication resources and skills, and a robust communication infrastructure can contribute to the closing of the digital divide and the overarching goal of Healthy People 2010 to eliminate health disparities."[1] Despite the intuitive connection between low health literacy and disparities, a recent review of the literature on health literacy[2] found only 1 study[3] documenting the link statistically. In this study, we used one of the only large datasets containing measures of health literacy, demographic characteristics, and health outcomes to explore the impact of health literacy on differences in health status and vaccination by educational attainment and race.

METHODS

Study Sample

Patient enrollment and data collection, which were conducted by the Prudential Center for Healthcare Research (now the Emory Center on Health Outcomes and Quality), have been described in detail previously.[4] Individuals newly enrolling in the Medicare managed care plans of Prudential Healthcare in 4 locations (Cleveland, OH; Houston, TX; South Florida, and Tampa, FL) between December 1996 and August 1997 were eligible to participate. New members were contacted 3 months after enrollment, and those meeting the eligibility criteria were asked to complete an in-person survey. To be included in the study, members had to be comfortable speaking either English or Spanish, living in the community, and possess adequate visual and cognitive function. Spanish-speaking patients were interviewed in Spanish. Of the 7,471 enrollees who were originally contacted, 3,247 refused to participate. The sample size for the analysis of differences by education level was 3,260. The sample size for the analysis for differences by race, which included only blacks and whites, was 2,850.

Data

Health literacy and selected demographic and health characteristics of the population were obtained from the baseline in-person survey. Health literacy was measured using the Short Test of Functional Health Literacy in Adults.[5,6] Based on their responses, subjects were classified as having either "adequate," "marginal," or "inadequate" health literacy.[6] The survey also included questions about respondents' demographics, socioeconomic status, chronic conditions ("Have you ever had. . ."), and health-related behaviors.

Our dependent variables, measures of health status and receipt of vaccination, were as follows: physical health SF-12, mental health SF-12, self-reported health status (fair or poor vs good, very good, or excellent), receipt of influenza vaccination, and receipt of pneumococcal vaccination. Survey questions on vaccination asked respondents whether they had ever received the vaccination. Independent variables were age (65 to 75, 75 to 84, 85+), gender, race/ethnicity (white, black, Spanish speaking, other), education (<8 years, 9 to 11 years, high school degree, some college, college degree), health literacy (inadequate, marginal, adequate), income (<$10,000,

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Address correspondence and request for reprints to Dr. Howard: Department of Health Policy and Management, Rollins School of Public Health, Emory University, 1518 Clifton Road NE, Atlanta, GA 30322 (e-mail: david.howard@emory.edu).

\$10,000 to \$25,000, >\$25,000, no response), tobacco (never, former, current) and alcohol (none, light to moderate, heavy) consumption, and self-reported chronic health conditions. For purposes of studying the impact of health literacy on differences by education level, we dichotomized the education variable into 2 categories: high school degree and no high school degree.

Analysis

We assessed differences in independent variables between groups using χ^2 tests. To determine the impact of health literacy on differences in the dependent variables by education and by race, we estimated 2 regression models for each dependent variable. The first included all of the independent variables listed above but omitted controls for health literacy; the second included controls for health literacy. We used ordinary least squares regression for continuous physical and mental SF-12 scores and logistic regression for the other dependent variables, which were dichotomous.

Because individual regression coefficients are difficult to interpret, we re-stated results from the regression models in terms of regression-adjusted, or predicted, values. Regression-adjusted values for physical and mental SF-12 scores are on the original scale. Regression-adjusted values for the other dependent variables, which are categorical, are probabilities. For each regression and dependent variable, we computed 2 adjusted values per respondent. We obtained the first value by recoding the education variables to indicate that the respondent had less than a high school education (regardless of the respondent's true level of education) and leaving the other independent variables as is. For the second value, we recoded the education variables to indicate that the respondent completed high school. We averaged these values across the sample and computed the difference, yielding the "sample average treatment effect" of education. This procedure effectively nets out the impact of the observed covariates. By comparing the magnitude of the average difference across regression models (one without health literacy controls, the other with), we determined the degree to which differences by education were mediated by health literacy. Because results are stated on the original scale, they are easier to interpret.[7] We repeated this procedure for race, computing each outcome as if everyone in the sample was black and then as if everyone in the sample was white. We used bootstrapping to determine the confidence intervals around the differences in regression-adjusted values.[8]

Table 1. Sample Characteristics by Education and by Race

	Education			Race		
	HS Degree	No HS Degree	*P* Value	White	Black	*P* Value
Sample size	2,093	1,167		2,466	384	
Health literacy			<.001			<.001
Adequate	78%	40%		71%	36%	
Marginal	9%	16%		10%	12%	
Inadequate	13%	45%		19%	52%	
Education			N/A			<.001
<8 y				10%	33%	
9 to 11 y				18%	28%	
High school				38%	24%	
Some college				22%	10%	
College				13%	5%	
Race			<.001			NA
White	86%	59%				
Black	7%	20%				
Hispanic*	4%	18%				
Other	3%	3%				
Male	42%	44%	.411	42%	34%	.001
Age			.027			.151
65 to 74	65%	62%		61%	66%	
75 to 84	30%	31%		33%	29%	
85+	5%	7%		6%	5%	
Site			<.001			<.001
Cleveland	25%	28%		28%	39%	
Houston	12%	22%		10%	42%	
Tampa	31%	24%		35%	7%	
South Florida	32%	26%		27%	12%	
Morbidity						
Heart attack	13%	16%	.033	15%	12%	.154
Angina	8%	11%	.002	10%	5%	.001
Stroke	8%	10%	.006	9%	10%	.551
High BP	44%	51%	<.001	45%	62%	<.001
COPD	17%	16%	.767	18%	15%	.113
Asthma	7%	8%	.809	7%	10%	.138
Cancer	6%	5%	.145	7%	3%	.002
Diabetes	13%	18%	<.001	14%	22%	<.001
Arthritis	50%	59%	<.001	54%	58%	.217
Depression	12%	17%	<.001	14%	9%	.010
Income			<.001			<.001
Missing	16%	16%		17%	8%	
0 to 10K	11%	30%		13%	39%	
10K to 15K	19%	25%		19%	30%	
15K to 25K	28%	21%		28%	17%	
25K to 35K	11%	4%		10%	4%	
35K+	14%	3%		13%	2%	
Smoker	61%	57%	.061	64%	51%	<.001

**Spanish-speaking only.*
NA, not applicable; COPD, chronic obstructive pulmonary disease; High BP, high blood pressure; HS grad, high school graduate.

RESULTS

Table 1 shows differences in health literacy, education, race, and other characteristics by education level (high school graduate vs not a high school graduate) and by race (white vs black). Differences in health literacy levels were substantial and significant ($P<.001$ in each case). For example, 78% of high school graduates, but only 40% of persons without high school degrees, had adequate health literacy.

Table 2 displays results from the fully adjusted regression model for the sample used in our analysis of educational differences in health status and vaccination rates. For the sake of brevity, we display results only for regression models that included health literacy. Compared with persons with adequate health literacy, persons with inadequate health literacy had significantly worse health outcomes and were significantly less likely to receive influenza vaccine. The coefficient on marginal health literacy was statistically significant in the model for the physical SF-12 score, but only marginally significant or not significant in the other models. Having a high school degree was positively and significantly associated with physical and mental SF-12 scores ($P=.013$ and .004) and the likelihood that self-reported health was good or better ($P<.001$). It was not significantly associated with receipt of influenza and pneumococcal vaccines ($P=.117$ and .206). Blacks were significantly less likely to report good or better health status compared with whites ($P=.012$) and were less likely to report receipt of influenza and pneumococcal vaccines ($P<.001$ and $P<.001$).

Table 2. Results from the Regression Models Used to Examine the Impact of Health Literacy on Differences by Education Level

	Ordinary Least Squares; B (*P* value)		Logistic Regression; OR (*P* value)		
	Physical Health SF-12	Mental Health SF-12 B (*P*-value)	SRHS is Good or Better	Influenza Vaccine OR (*P*-value)	Pneumococcal Vaccine OR (*P*-value)
Health literacy					
Adequate	—	—	—	—	—
Marginal	– 1.35 (.019)	0.46 (.304)	0.77 (.060)	1.06 (.707)	0.91 (.445)
Inadequate	– 2.53 (<.001)	– 1.41 (<.001)	0.71 (.004)	0.76 (.020)	0.85 (.114)
HS degree	1.03 (.013)	0.93 (.004)	1.46 (<.001)	1.18 (.117)	1.12 (.204)
Female	– 1.28 (.001)	– 0.77 (.010)	0.93 (.408)	0.84 (.084)	1.11 (.211)
Age (y)					
65 to 74	—	—	—	—	—
75 to 84	– 1.13 (.004)	– 0.22 (.465)	0.92 (.366)	1.13 (.233)	1.32 (.001)
85+	– 3.64 (<.001)	– 0.10 (.871)	1.27 (.209)	1.51 (.058)	1.15 (.407)
Race					
White	—	—	—	—	—
Black	0.48 (.425)	– 0.27 (.565)	0.68 (.012)	0.60 (<.001)	0.43 (<.001)
Hispanic*	2.26 (.001)	0.32 (.546)	0.59 (.001)	0.50 (<.001)	0.45 (<.001)
Other	0.80 (.441)	0.24 (.767)	1.15 (.551)	0.56 (.016)	0.61 (.034)
Site					
Cleveland	—	—	—	—	—
Houston	– 1.88 (.001)	– 1.35 (.002)	0.91 (.514)	1.05 (.746)	1.23 (.090)
Tampa	– 1.98 (<.001)	0.54 (.149)	1.02 (.870)	1.10 (.458)	0.92 (.423)
South Florida	– 0.81 (.103)	– 0.24 (.533)	0.95 (.685)	0.71 (.006)	0.68 (<.001)
Morbidity					
Heart attack	– 3.04 (<.001)	0.24 (.566)	0.62 (.001)	1.24 (.157)	1.11 (.345)
Angina	– 4.39 (<.001)	– 1.19 (.017)	0.36 (<.001)	1.16 (.421)	1.39 (.015)
Stroke	– 4.64 (<.001)	– 1.47 (.003)	0.44 (<.001)	1.41 (.065)	1.05 (.697)
High BP	– 1.23 (.001)	– 0.60 (.030)	0.66 (<.001)	1.17 (.086)	1.26 (.003)
COPD	– 4.07 (<.001)	– 0.29 (.534)	0.60 (.001)	1.52 (.021)	1.78 (<.001)
Asthma	– 1.24 (.143)	– 1.00 (.130)	0.51 (.004)	0.90 (.666)	1.13 (.514)
Cancer	– 3.78 (<.001)	0.57 (.313)	0.49 (<.001)	1.00 (.982)	0.94 (.700)
Diabetes	– 4.05 (<.001)	– 1.14 (.003)	0.37 (<.001)	1.77 (<.001)	1.09 (.404)
Arthritis	– 5.01 (<.001)	0.07 (.807)	0.57 (<.001)	1.25 (.015)	1.19 (.027)
Depression	– 1.48 (.004)	– 13.07 (<.001)	0.63 (.001)	1.23 (.153)	0.85 (.144)
Income					
Missing	—	—	—	—	—
0K to 10K	– 1.62 (.008)	– 0.65 (.170)	0.79 (.107)	0.82 (.189)	0.84 (.185)
10K to 15K	– 0.69 (.231)	– 0.13 (.766)	1.01 (.931)	0.72 (.027)	0.96 (.746)
15K to 25K	– 0.20 (.721)	0.35 (.415)	1.18 (.205)	1.12 (.461)	1.02 (.893)
25K to 35K	0.99 (.180)	1.13 (.047)	1.63 (.003)	0.91 (.604)	1.01 (.957)
35K+	1.03 (.150)	0.59 (.292)	1.90 (<.001)	1.19 (.369)	1.13 (.419)
Smoker	– 1.11 (.003)	0.22 (.440)	0.86 (.076)	1.22 (.037)	1.21 (.019)
Constant	54.42 (<.001)	57.29 (<.001)	0.37 (2.000)	1.11 (5.490)	– 0.62 (<.001)

*Spanish-speaking only.
High BP, high blood pressure; COPD: chronic obstructive pulmonary disease; SRHS: self-reported health status; OR, odds ratio.

Differences in SF-12 scores between blacks and whites were insignificant.

Actual and regression-adjusted health status scores and vaccination rates are displayed in Tables 3 and 4. The first column in Table 3 shows the unadjusted means of each dependent variable by education level. For dichotomous independent variables (for e.g., receipt of influenza vaccine), the mean is a proportion. The second column displays regression-adjusted values (or, equivalently, "predicted values") from a regression model that excluded controls for health literacy. The third column displays the regression-adjusted values from a regression model that included controls for health literacy.

The difference in regression-adjusted physical health SF-12 scores between high school graduates and nongraduates from the model that excluded health literacy controls was 1.7. The difference from the model that included health literacy controls was 1.0. Thus, controlling for health literacy decreased the adjusted difference by 0.7 (95% confidence interval [CI]: 0.4 to 0.9) or 41% (≈0.7 ÷ 1.7). For the other dependent variables, controlling for health literacy decreased the estimated difference by approximately one-fourth, although the magnitude of the effect was small. For example, a model with health literacy controls predicted that the probability that a survey respondent with a high school degree received influenza vaccination was 0.799 (or about 80%) versus 0.762 for a respondent without a high school degree. The difference was 0.037 versus 0.027 for a model that omitted health literacy controls, a difference between models of 0.010 (95% CI: 0.001 to 0.020) or, equivalently, 1 percentage point.

Table 4 displays the effect of controlling for health literacy on differences between blacks and whites. The difference in mean physical health SF-12 scores between whites and blacks was 1.3. This difference was entirely explained by the observed respondent characteristics; regression-adjusted physical SF-12 scores from the full model, which included health literacy, were actually higher for blacks than for whites. The difference in regression-adjusted values from the regression model that

Table 3. Impact of Controlling for Health Literacy on Differences in Health Status and Vaccination by Education

Education	Mean	Regression adjusted		Difference Between Models (95% CI)
		No HL Controls	With HL Controls	
Physical health SF-12 (score 0 to 100)				
HS degree	46.2	45.6	45.4	
No HS degree	43.0	43.9	44.4	
Difference by education level	3.2	1.7	1.0	0.7 (0.4 to 0.9)
Mental health SF-12 (score 0 to 100)				
HS degree	55.7	55.1	55.0	
No HS degree	53.0	53.9	54.1	
Difference by education level	2.6	1.2	0.9	0.3 (0.1 to 0.5)
Self-reported health is good or higher (probability 0 to 1)				
HS degree	0.42	0.39	0.38	
No HS degree	0.24	0.30	0.31	
Difference by education level	0.18	0.09	0.07	0.02 (0.01 to 0.03)
Receipt of influenza vaccine (probability 0 to 1)				
HS degree	0.809	0.799	0.795	
No HS degree	0.742	0.762	0.769	
Difference by education level	0.067	0.037	0.027	0.010 (0.001 to 0.020)
Receipt of pneumococcal vaccine (probability 0 to 1)				
HS degree	0.46	0.44	0.44	
No HS degree	0.38	0.41	0.41	
Difference by education level	0.08	0.04	0.03	0.010 (−0.002 to 0.022)

HL, health literacy; HS, high school; CI, confidence interval.

excluded health literacy controls was minimal: 0.1. The difference between models was 0.60 (95% CI: 0.32 to 0.85).

The difference between models examining the likelihood that self-reported health status was good or better was 0.02 (95% CI: 0.01 to 0.03), or 2 percentage points. The models for receipt of influenza and pneumococcal vaccinations indicated that black enrollees were substantially less likely to receive vaccinations than whites. For example, the probability that a black enrollee received influenza vaccine at any point during his or her life, adjusted for observable covariates (including health literacy), was 0.747 versus 0.820 for whites, a difference of 0.074. However, health literacy had only a small and nonsignificant effect on measured differences: 0.009 (95% CI: −0.001 to 0.20) and 0.003 (−0.007 to 0.013), respectively.

DISCUSSION

We found that health literacy explained a small fraction of the differences in health status and, to a lesser degree, receipt of vaccinations that would normally be attributed to educational attainment or race if literacy was not considered. Controlling for health literacy reduced adjusted differences by educational attainment in physical and mental health SF-12 scores by 25%

Table 4. Impact of Controlling for Health Literacy on Differences in Health Status and Vaccination by Race

Education	Mean	Regression adjusted		Difference Between Models (95% CI)
		No HL Controls	With HL Controls	
Physical health SF-12 (score 0 to 100)				
White	44.9	44.7	44.6	
Black	43.6	44.6	45.1	
Difference by race	1.3	0.1	−0.5	0.6 (0.3 to 0.9)
Mental health SF-12 (score 0 to 100)				
White	55.7	54.8	54.8	
Black	53.0	54.3	54.6	
Difference by race	2.6	0.5	0.2	0.3 (0.1 to 0.5)
Self-reported health is good or higher (probability 0 to 1)				
White	0.39	0.38	0.38	
Black	0.23	0.30	0.31	
Difference by race	0.16	0.08	0.06	0.02 (0.01 to 0.03)
Receipt of influenza vaccine (probability 0 to 1)				
White	0.826	0.820	0.819	
Black	0.701	0.747	0.755	
Difference by race	0.126	0.074	0.065	0.009 (−0.001 to 0.020)
Receipt of pneumococcal vaccine (probability 0 to 1)				
White	0.48	0.48	0.48	
Black	0.29	0.30	0.30	
Difference by race	0.19	0.19	0.18	0.003 (−0.007 to 0.013)

HL, health literacy; CI, confidence intervals.

to 41%, respectively. While there is no universally agreed upon standard for what constitutes a "clinically meaningful" difference, these differences fall below the thresholds for clinical significance commonly cited in the quality-of-life literature.[9,10]

The (unadjusted) difference that we observed in self-reported health status between high school graduates and enrollees without a high school degree was about the same as in the general population, but the difference by race was over twice as large.[11] Our results indicate that if health literacy levels were similar, differences in self-reported health status by education and by race would be about 20% to 25% lower.

Observed differences in receipt of influenza and pneumococcal vaccinations were generally in line with those reported elsewhere.[12,13] In contrast to the findings for self-reported health status, differences in health literacy did not appear to explain much if any of the differences in receipt of vaccinations. Our results should be interpreted cautiously as these data were drawn from a survey of managed care enrollees. Managed care plans encourage beneficiaries to use preventive services, and, in doing so, may diminish the differences in preventive service use by education and race attributable to differences in health literacy. Indeed, use of cancer screening tests was uniformly high among survey respondents (data not shown). Previous research has found that managed care differentially increases use of preventive care among beneficiaries with less than 12 years of education.[14] Findings with respect to the impact of managed care on differences by race are mixed.[15–19]

Although these data did not permit us to investigate possible mechanisms by which health literacy influences disparities, past research on the relationship between education and health provides indirect evidence. Goldman and Smith[20] found that well-educated patients are better able to manage complicated self-care regimens in HIV/AIDS and diabetes. Other studies have found that education is linked to faster adoption of new medical technologies[21] (although not all studies have found this result[22]) and that consumer knowledge is linked to increased use of preventive care.[23] Of course, it is not altogether surprising that controlling for health literacy reduces observed differences by educational attainment, literacy being a more direct measure of ability than years of schooling.

Our study has a number of limitations. First, the response rate to the survey was less than 60%. An analysis of nonresponders' ZIP codes, which were obtained from Prudential Healthcare's enrollment file, suggests that high school graduates and whites were overrepresented among nonresponders.[4] Second, the Short Test of Functional Health Literacy in Adults does not fully capture all dimensions of the concept of health literacy (for e.g., oral literacy). Third, health literacy measurements may also be correlated with unobserved variables, such as occupation and social class that, if included in regression models, might account for the effects attributed to literacy in our study. Fourth, external validity is limited by the fact that our study sample was comprised entirely of elderly Medicare managed care enrollees in the South and Midwest.

Practically, this research indicates that programs to improve health literacy have the potential to reduce health disparities, but probably only by a small to moderate amount. That said, interventions to improve health system access among persons with low health literacy are probably inexpensive compared with larger, structural changes to the health system, and thus ought to be considered as part of an overall strategy to reduce disparities.

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